Properties of Zn doped CdO nanorods and Ni doped CdO nanosheets synthesized by Hydrothermal Method

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Abstract:
In this study, Zn doped CdO and Ni doped CdO nanostructures were synthesized on glass substrates by using Hydrothermal Synthesis Technique. Effects of Zinc and Nickel materials on the nanostructures were investigated. The morphological, structural, and optical properties of Zn and Ni doped CdO nanostructures were characterized by SEM, XRD and UV-Vis techniques, respectively.

Keywords: *CdO nanostructures, Chemical Bath Deposition Technique, FTO, glass, Ni, Zn*

I. INTRODUCTION

In the past decades, cadmium oxide (CdO) is very popular material for photovoltaic applications, due to its electrical conductivity and transparency in the visible region of the light [1]. This material is an n type semiconductor with direct band gap between 2.2- 2.7 eV values [1,2]. Additionally, semiconductor metal oxides with one-dimensional nanoscale have attracted much attention because of their low-dimensional effects for nanodevices applications [3]. CdO films are growth by several methods such as solvothermal [4], electrochemical deposition [5], spray pyrolysis [6] and chemical bath deposition [7, 8].

In the study, Zn and Ni doped CdO nanostructures were synthesized by hydrothermal synthesis method. Structural, morphological and optical properties of the CdO films were investigated by using, SEM (FEI Quanta 450 FEG-SEM), XRD (Panalytical Empyrean X-ray diffractometer), UV-Vis (TETRA T80+) spectrophotometer measurements.

II. EXPERIMENTAL DETAILS

In the experiment, the Hydrothermal precursor solution was prepared using $Cd(OH)_2$, $Zn(OH)_2$, $Ni(OH)_2$ precursors. The bare glasses were used as a substrate, they were immersed in the bath solution with the Teflon lined stainless steel autoclave (50 ml), and as-deposition process was achieved at 100 ° C for 3h. After, the deposition process, the substrates were exposed to heat treatment at 50-60° C until they dry. Finally, as prepared films were annealed at 500 °C for 2 hours in air.

Optical and structural features of the Ni and Zn doped CdO nanostructures were characterized by SEM, XRD and UV-Vis measurements.

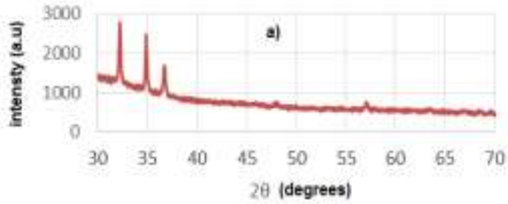
III. RESULTS AND DISCUSSION

In the Fig.1, XRD patterns show crystal structure of the Zn doped CdO and Ni doped CdO. İt was obtained wurtzite ZnO peak at (002) plane (2θ approximately 35º) and cubic CdO peak at (111) plane (2θ approximately 32º) for Zn doped CdO nanostructures. At the same time, low intense cubic NiO peak at (200) plane (2θ approximately 44º) and low intense cubic CdO peak at (111) plane (2θ approximately 32º) were obtained for Ni doped CdO nanostructures. Details of the XRD data are given in the Table 1.

Table 1. XRD datas of the Nanostructures

Samples	2θ (degrees)	(h k l)	d values (Å)
ZnCdO/ Glass	32.25 34.91 36.73 57.00	(111) CdO (002) ZnO/(011)$Cd(OH)_2$ (011) ZnO/(002) CdO (022) CdO/ (110) ZnO/ (111) $Cd(OH)_2$	2.77341 2.56821 2.44475 1.61428
NiCdO/ Glass	32.15 37.00 43.77	(111) CdO (002) CdO/(111) NiO (200) NiO	2.78170 2.39832 2.06667

SEM images and EDS spectra for all the samples were shown in Fig. 2 and Fig. 3. From the figures what we saw that nanoflower like nanorods were obtained for Zn doped CdO and nanosheets were obtained for Ni doped CdO. Additionally, it is clear that these nanorods and nanosheeets dispersed homogenously throughout the surface. According to EDS spectra, Ni, Zn, Cd and O peaks emerged very intense.



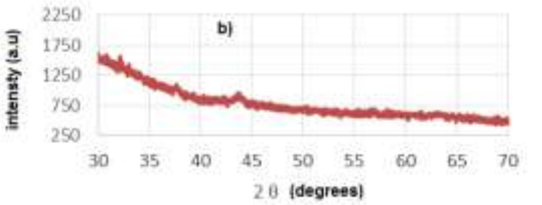


Figure 1. XRD spectra of the **a)** Zn doped CdO **b)** Ni doped CdO.

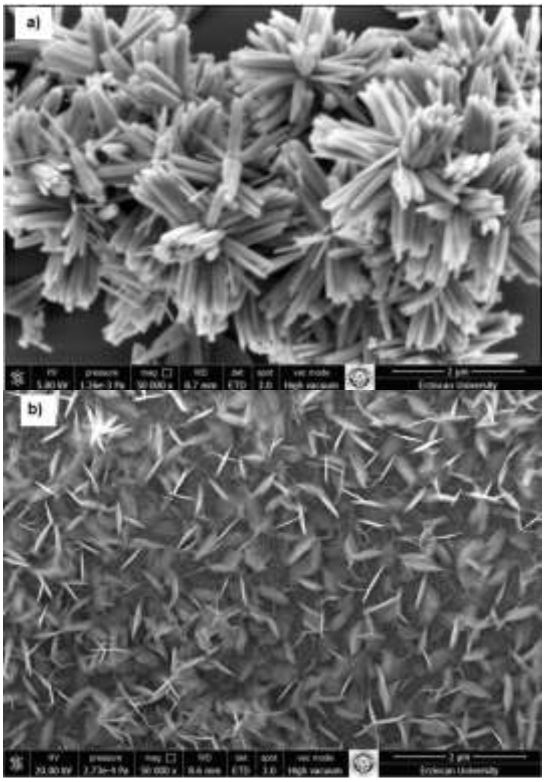
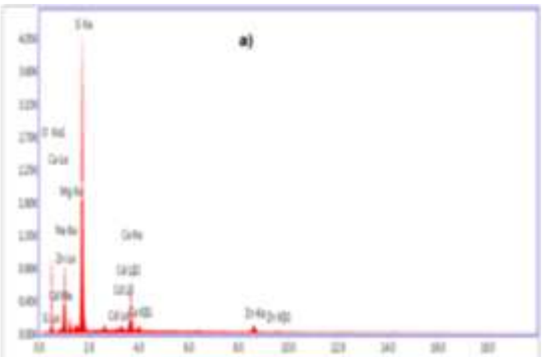


Figure 2. SEM images of the **a)** Zn doped CdO **b)** Ni doped CdO.



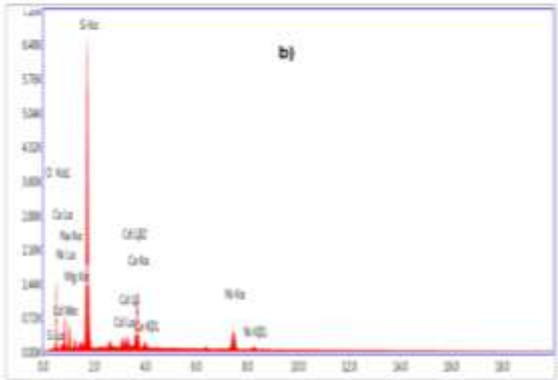


Figure 2. EDS spectra of the a) Zn doped CdO b) Ni doped CdO.

Fig .4 shows UV-Vis absorbance spectra of the Zn doped CdO and Ni doped CdO nanostructures. Maximum transmittance was obtained for Zn doped CdO nanostructure (approximately 24 %) and Ni doped CdO nanostructures (approximately 52 %). Calculated optical band gap values are 4.02 and 3.82 eV for Zn doped CdO and Ni doped CdO nanostructures respectively.

Bandgap of the bulk CdO is lower value than the calculated optical bandgap values of Zn doped CdO and Ni doped CdO nanostructures [2]. According to Moss–Burnstein shift, the energy band to widen arising from the increase of the Fermi level in the conduction band [9].

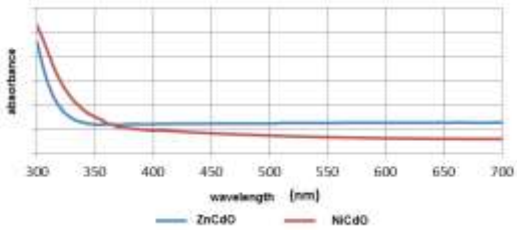


Figure 3. UV-Vis Spectra of the Zn doped CdO and Ni doped CdO.

IV. CONCLUSIONS

As a result, in this study, the Zn and Ni doped CdO nanostructures were synthesized by using hydrothermal synthesis method. It was obtained that Zn doped CdO has wurtzite ZnO and cubic CdO crystal structure, flower like nanorod morphology. Additionally, it was obtained that Ni doped CdO has cubic CdO-NiO crystal structure and nanosheet morphology. The band gaps were calculated higher value than bulk CdO for each sample.

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